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ABSTRACT

Project PRISE (Project to Improve Science Education) was designed to improve science preparation for preservice elementary teachers. Because students were familiar with water, and because water was so abundant in the project area (Grand Valley State University, Michigan), it was chosen as the theme. The PRISE curriculum development process began with identification of the theme. The idea's component features were developed (audience, objectives, courses, and evaluation). Extensive discussion, interaction, and research was very important in expanding faculty understanding of elementary science education, how science is learned, and how science can be taught to foster greater understanding. The learning and sharing phases were followed by the creative course-development phase. Once courses were developed and approved, they were piloted, evaluated, and revised. PRISE begins with a course entitled "Great Lakes and Other Water Resources." It is followed by disciplinary courses in earth science, physical science, and chemistry. Three appendices offer a PRISE reading list, concepts maps for courses and workshops, and the "Water, Water Everywhere" booklet for children. (SM)

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WATER, WATER EVERYWHERE

An Integrated Approach to

Science Preparation for Elementary Teachers

Presented at the Annual Meeting of the
Association of Teacher Educators
February 17, 1992

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WATER, WATER EVERYWHERE
An Integrated Approach to Science Preparation for Elementary Teachers

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Water is found throughout the world, but it is particularly abundant in West Michigan, the home of Grand Valley State University. Because most students are familiar with water both for survival and in nature, we have chosen it as the theme for a project funded by the National Science Foundation to improve the science preparation of prospective elementary teachers.

In this discussion of this project, a model of the course development process, its impact on curriculum, professors, and students is presented. In addition, some of the background information gained by project faculty members is reviewed.

THE COURSE DEVELOPMENT PROCESS

The primary goal in developing a model of the course development process for the Project to Improve Science Education (PRISE) is to facilitate replication of PRISE at other institutions. This model has five phases (Figure 1) and is an adaptation of the process models shared by Allan A. Glatthorn (1987) in his monograph entitled, Curriculum Renewal.

Figure 1 FIVE PHASES OF THE PRISE CURRICULUM DEVELOPMENT MODEL

Phase One:	Formulating the Idea
Phase Two:	Identification of Project Components
Phase Three:	Sharing and Gaining Information for Implementation
Phase Four:	Creating, Developing and Piloting PRISE Courses
Phase Five:	Sharing the PRISE Model

PHASE ONE. The first phase in the PRISE curriculum development model has been labeled, **Formulating the Idea**. It has three steps as noted in Figure 2.

Figure 2 MODEL FOR REPLICATING PRISE
Phase One: FORMULATING THE IDEA

Step 1: Brainstorming and Discussing the Kernel of the Idea

Step 2: Crystallizing the Idea

Step 3: Developing the Idea into a Project Plan

Phase One, Step 1: Brainstorming and Discussing the Kernel of the Idea

Step 1 includes brainstorming and discussing the kernel of the idea behind the project. This step involved discussions with National Science Foundation (NSF) staff about the unique success Grand Valley State University (GVSU) has had in using the D. J. Angus research vessel both with teachers and with elementary age students to get them excited about science. After positive response to the idea of using a water theme and the Angus to excite prospective teachers about science, it was shared and expanded in conversations with others.

Phase One, Step 2: Crystallizing the Idea

Crystallization of the idea occurred through discussions. It was, then, expanded into a proposal for review.

Phase One, Step 3: Developing the Idea into a Project Plan

With proposal development began the more formal structure of the curriculum development process. It is during this step that the project actually took shape. This formal structure provides the core ideas of PRISE that may be replicated by other institutions after having "played with the idea" of using a thematic approach to excite prospective elementary teachers about science.

PHASE TWO: The identification of project components that make up the five steps in phase two, flows from the development of the project plan in phase one. The second phase of the curriculum development of PRISE gives the project its shape. It consists of a series of five steps (Figure 3).

Figure 3 MODEL FOR REPLICATING PRISE

Phase Two: IDENTIFICATION OF PROJECT COMPONENTS

Step 1. Identify the desired outcomes as goals
"What do you want to achieve?"

Step 2. Identify a local resource to serve as a theme for investigation
"What are some environmental resources that could be used for investigation?"

Step 3. Identify the parameters for the project
"What is the extent of the project?"

Step 4. Identify faculty and staff members who will be involved in the project
"Who should/will be involved?"

Step 5. Identify funding sources and initiate approval process
"How can the project be implemented?"

Making a difference in the science preparation of prospective teachers was identified and affirmed in step one as the desired outcome and primary goal of PRISE. In step two, water was affirmed as the environmental resource theme. Steps three and four address the parameters of the project and the faculty and staff who will be involved in the project. These steps outline possibilities as the project becomes a proposal. After the project is approved, these steps will be reviewed and revised as the project implementers confront the realities of personnel, budgets, timelines and departmental concerns. These steps involve internal recognition and reaffirmation of the importance of the project by the individuals who would be called upon to implement it.

Phase Two, Step 1. Identify the desired outcomes as goals "What do you want to achieve?"

One of the first steps in the identification phase involves the identification of the goals as desired outcomes of the project (Figure 4). These goals could be adopted or adapted by other institutions wishing to replicate PRISE.

Figure 4 PRISE GOALS

- Improve science instruction in the elementary classroom
- Provide preservice elementary teachers with a better background in science content and science process skills
- Increase prospective elementary teachers' interest and understanding of science.

PRISE Proposal to NSF, 1988, p. 7

Phase Two, Step 2. Identify a local resource to serve as a theme for investigation--"What are some environmental resources that could be used for investigation?"

After identifying the project goals, each institution will want to identify the environmental resource theme for the project. For PRISE, it was water. Other natural resource themes, which could be used as a unifying theme are suggested in Figure 5. Themes that might be discussed include air and weather; soil, rocks and minerals; city ecology; or a geographic land form.

Figure 5 POTENTIAL ENVIRONMENTAL RESOURCE THEMES PROVIDING POSSIBILITIES FOR INVESTIGATION

- Water, e.g. fresh water lakes, rivers, streams, ponds, and wetlands; Salt water, estuaries, bays, and oceans
- Air and Weather
- Soil, Rocks and Minerals

- City Ecology

- Terrestrial environments, e.g. mountains, plains, deserts, forests, everglades

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Phase Two, Step 3. Identify the parameters for the project
"What is the extent of the project?"

Once the theme is confirmed, the curricular parameters need to be clarified. Two parameters determine the extent of the project: the **courses** and **faculty members** to be included. The anticipated curricular outcomes e.g. course descriptions, course proposals, scope and sequence chart, course of study, are identified and associated with courses. In the original Grand Valley State proposal, the curricular outcomes included the development of one new course and modifications in three current courses as noted in Figure 6. It may be desirable to leave room for curricular variation since faculty members may develop new ideas as the project progresses.

Figure 6 **A SUMMARY OF THE PROPOSED NEW PROGRAM**

```
                   A new course      Modified existing        New offerings or
                   required of all   courses with special     modifications of
                   entering pre-     discussions added.       existing courses to
                   service elemen--  Students elect a         fit this program
                   tary teachers     minimum of 2 of 3.       and provide a science
                                                              minor or major for
                                                    |--->     preservice elemen-
                                     |-> BIOLOGY 111----|     tary teachers (exact
                                     |      |           |     number to be
                                     |    Discussions   |---> determined).
All entering                         |                  |
preservice             OUR           |                  |
elementary ---->      WATER    --->|-> CHEMISTRY 111--|
teachers.           RESOURCES       |      |           |
                                     |    Discussions   |--->
                                     |                  |
                                     |-> GEOLOGY 111----|
                                            |           |
                                          Discussions   |--->
```

PRISE Proposal to NSF, 1988, p. 7

Phase Two, Step 5. Identify funding sources and initiate approval process
"How can the project be implemented?"

Phase Two is completed only after the project is accepted and approved as part of Step 5. As the project proposal winds its way through the approval and acceptance process on campus and at funding agencies, a hiatus occurs in the PRISE curriculum development process. Along the way, some adjustments may need to be made in the project's parameters, timeline or funding. After negotiation and approval processes are complete, the project is ready for implementation.

PHASE THREE: Once the goals, theme, parameters, and faculty are identified and the project is approved and funded, the third phase of curriculum development begins--that of **Sharing and Gaining Information for Implementation**. Like phases one and two, phase three consists of a series of steps outlined in Figure 7. This phase is the most time consuming and complex of the phases. Up until this point, PRISE was an idea. In Phase Three, PRISE begins to become a reality through sharing the idea with the implementers.

Figure 7 MODEL FOR REPLICATING PRISE

Phase Three: SHARING AND GAINING INFORMATION FOR IMPLEMENTATION

Step 1. Share the desired goals and objectives with the faculty
"How can we achieve these goals and objectives together?"

Step 2. Share the theme, pedagogical framework and the investigative process along with expectations for the various courses and student population(s)
"What are the expectations for courses, students, and faculty?"

Step 3. Provide opportunities for faculty members to become familiar with developments in science education through attendance at conferences, bringing experts in to share their perspectives, through faculty interactions and participation in the theme course's content and processes with PRISE students and other faculty members, sharing of articles and books on science education, and visits to elementary science and regular classrooms.

Phase Three, Step 1. Share the desired goals and objectives with the faculty "How can we achieve these goals and objectives together?"

Phase three of the curriculum development process begins with sharing the goals and objectives of the project. This fosters the same expectations and understandings among project faculty. With a common set of understandings, it is more likely that the project participants will meet the desired goals.

The PRISE objectives relate to both curriculum development and to the long-range objectives for project participants. Each PRISE faculty member takes the objectives and relates them to his or her course. The PRISE objectives for prospective elementary teachers are listed in Figure 8.

Phase Three, Step 2. Share the theme, pedagogical framework and the investigative process along with expectations for the various courses and student population(s) "What are the expectations for courses, students, and faculty?"

The theme course, Our Water Resources, establishes the foundation for operationalizing the goals, objectives, theme, pedagogical framework, investigative process, and expectations of the project. Thus, this course was developed first and the other courses build upon it. Within Our Water

Resources, the PRISE pedagogical framework, as illustrated in Figure 9, builds upon the investigations, data collection and predictions carried out by students in the water related activities done in the laboratory and field experiments that are part of the theme course.

Figure 8 PRISE OBJECTIVES FOR PROSPECTIVE ELEMENTARY TEACHERS

- To increase interest in science

- To increase both breadth and depth of science knowledge by encouraging students to elect more science courses and to choose a minor or major in science

- To increase understanding of the relationships between science, technology, and society

- To increase the students' "comfort level" with science, thus increasing the probability of their offering more and better science education in their classrooms when they become teachers

- To teach science content which is needed by the elementary teacher rather than that which is only applicable to advanced study in a science discipline

- To teach and model classroom methodology in science content courses, including a requirement that students develop information and materials which can be applied in the classroom (lesson plans, laboratory and field activities, sources)

- To effectively combine the teaching of science content with the process approach

PRISE Proposal to NSF, 1988, p. 6

Figure 9 PRISE PEDAGOGICAL FRAMEWORK

```
       ------->   Leads to improvements    Results in elementary
      /           in the students:         teachers with increased:
     |                   |                           |
     |                   |                           |
     |                   V                           V
The collection,   - understanding of       - knowledge of science content
analysis and        science concepts
discussion of                              - willingness to explore more
water resources   - confidence and           science
data                competence with
                    science                - understanding of the role of
                                             science and its application in
                                             the classroom
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PRISE Proposal to NSF, 1988, p. 7

Embedded in the project are numerous assumptions about learning. They are most clearly evident in the five characteristics of the theme course listed in Figure 10.

Figure 10 **OUR WATER RESOURCES**
(Course Characteristics Based on Assumptions About Learning)

1. Uses a familiar environmental resource--WATER

2. Builds on prior knowledge and a series of common experiences to develop a greater understanding of scientific phenomena

3. Activities course with students acting as scientists--gathering data and making observations

4. Discusses data, observations, interpretations and results to formulate an understanding of the implications of findings

5. Integrates science content from biology, chemistry, earth science and physics

PRISE Proposal to NSF, 1988, p. 7

The characteristics were shared and discussed without investigating their theoretical bases. However as the curriculum development model was developed, possible theoretical groundings for the characteristics were explored and are shared herein.

The **first characteristic of the theme course** (Figure 10, item 1) is its use of WATER, a **familiar environmental resource**. Most students from western Michigan are familiar with water as a natural resource as had been evident to G.V.S.U. faculty when they took teachers and pupils on field trips using the D. J. Angus research vessel. Such experiences suggested that prospective teachers would be receptive to taking a science course with a water theme.

The **second** learning theory assumption relates to the importance of **prior learning** serving as a base for future learning (Figure 10, item 2). This was written into the original proposal in the statement, "Building on that which is familiar is the easiest way to approach the unfamiliar." (PRISE Proposal, p. 7.)

The use of prior learning as a building block for future learning is consistent with research on learning science as noted by Confrey when he states that "students enter instruction with firmly held beliefs and explanations for phenomena and relationships, and these beliefs are subject matter-specific and can be identified and confirmed only through methods that encourage children to be expressive and predictive" (1990, p. 4). As professors investigate and use students' prior learning in motivating, structuring and guiding new learning activities, they are modeling appropriate classroom methodology. Such modeling is also found in the Water, Water Everywhere hand out (found in the Appendix) for children. It uses a variation on the reading KWL strategy in which you ask pupils: What do you already KNOW about the topic? What do you WANT to know about it? After doing activities related to the topic, the final questions is asked--What did you LEARN about the topic.

The theme course, Great Lakes and Other Water Resources, (revised from Our Water Resources), takes an **activities approach to teaching and learning** science (Figure 10, item 3). Numerous cognitive psychologists and educators from the past century e.g. Piaget, Montessori, Dewey, Leont'ev have encouraged the use of activities as a teaching/learning strategy. As summarized in What Works: Research about Teaching and Learning, "Children learn science best when they are able to do experiments, so they can witness 'science in action.'" (U. S. Department of Education, 1986, p 23). This rationale is discussed below.

PIAGET: Piaget and his followers study how children learn concepts (Confrey, 1990). When learning science from experience, one needs to have opportunities for integrating that knowledge into the knowledge base already developed (Piaget, 1971, p. 108). Thus, present and prior learning are related.

More recently the relationship between active learning and the development of understanding has been explored through High/Scope (Hohmann, Banet, and Weikart, 1979), an early learning program based on Piaget's research. In the High/Scope curriculum, there are three phases in the active learning process--plan, do, review. Planning permits students to initiate and organize their time and learning. It motivates learning and establishes an anticipatory set (Hunter, 1984) based on their own thinking. Sharing one's planning permits peer and teacher interaction with the student and the plan.

Once the plan is decided, the student carries out the plan. Doing provides the students with an opportunity for active participation in learning. The actions a student carries out can provide links with prior experiences.

The review process serves two purposes. It requires students to translate their experiences into language and permits them to check their thoughts and results against those of other "novice scientists". As sharing occurs, students challenge each other and encourage their peers to discuss the observations and thinking processes that contributed to their conclusions. Such sharing is likely to develop greater understanding both of the science concepts and of the metacognitive processes (how they think about thinking) students use (Whimbey and Lockhead, 1982). By taking liberty with this process of planning, doing and reviewing, it can be developed into an active learning sequence appropriate for use in learning science, as proposed on Figure 11.

Figure 11 POSSIBLE ACTIVE LEARNING SEQUENCE FOR SCIENCE

1. PLAN
   - Determine what you want to find out
   - Predict or hypothesize what you think you will observe
   - Determine how you could test your prediction or hypothesis
2. DO
   - Set up and/or carry out tests
   - Collect and record data
   - Make observations and generalizations
   - Retest and compare
3. REVIEW
   - Share data and observations
   - Suggest interpretations
   - Discuss how you know what you know
   - Consider possible generalizations and/or implications

Active learning is commonly accepted as appropriate for young learners. However, the American Association for the Advancement of Science (1990), suggests that science should be taught in colleges as it is practiced, with

> "both active engagement with the objects and phenomena of the natural world and conversations with instructors and peers about these experiences" (p. 29).

Thus, active learning is an appropriate teaching strategy to use with prospective elementary teachers and for them to emulate in their own teaching.

The learning cycle (Figure 12) originally developed by the Science Curriculum Improvement Study (SCIS) substitutes lesson focus for the planning phase. In the learning cycle, the teacher plans the activity rather than the student. The student carries out the teacher's plans through a three phase cycle of Exploration, Concept Introduction, and Concept Application (Barman and Kotar, 1989).

Figure 12 **Learning Cycle**

Exploration. In the beginning of the Learning Cycle, students explore new materials and ideas. They make observations and collect data. The teacher assumes the role of facilitator or observer, posing questions and assisting students individually and in small groups.

Concept Introduction. During this phase, the teacher guides students in large group discussions. Together they organize observations and data collected during Exploration and try to find patterns that may exist. These patterns often reveal concepts being defined in the lesson. The teacher introduces vocabulary related to the concept and may rely on textbooks, audio-visual aids, and other materials to further develop concepts.

Concept Application. At this time, the teacher poses a new situation or problem that students can solve by applying or extending the new concept. This phase often involves students in additional hands-on activities that reinforce understanding of the concepts. As in the Exploration phase, the teacher works with individual students and small groups.
(Barman and Kotar, 1989, p. 30.)

As this sequence implies, this is a cyclical process that continues as students continue to build new concepts on former concepts and experiences.

When students share how they understand what they are learning in science or in other subjects, it becomes easier for the teacher to evaluate the students' conceptualizations of the subject and its processes and to identify where students may have misinterpreted the data or developed a misconception. It also aids in identifying what experiences need to be addressed next, in order to build on this new knowledge as prior knowledge.

MONTESSORI: The link between prior knowledge and learning through direct experience also was pointed out by Montessori when she states, "our children at

six years of age already possess much and varied knowledge in biology, geography, mathematics, etc., which they gain from direct contact with a visible apparatus that can be manipulated" (Montessori, 1955, pp. 136-137).

DEWEY: Dewey's basic assumption, "that amid all uncertainties there is one permanent frame of reference; namely, the organic connection between education and personal experience" (Dewey, p. 25). He also indicates that "finding the material for learning within experience is only the first step. The next step is the progressive development of what is already experienced into a fuller and richer and also more organized form" (pp. 72-73). This expanded organization facilitates a greater depth and breadth of understanding of a subject.

LEONT'EV: Activity theory (Leont'ev, 1981) as outlined in Figure 13 differs from active learning in that it deals with relating the physical world to cognitive processes used by the learner through an activity. Although little has been written in English which relates activity theory to science, it seems to be appropriate to use it when promoting scientific literacy. Thus, a link is being suggested between activity theory and PRISE, since in each, goals become operationalized through an activity and it is the activity that provides both the basis for learning and the linkages between understandings.

Figure 13 **ACTIVITY THEORY**

ACTIVITY THEORY suggests that motives and goals,
as well as operations
(e.g. pattern identification, prediction, inferencing),
are all intrinsic parts of a process.

From this perspective,
THE FUNDAMENTAL UNIT OF LEARNING for a person
IS THE ACTIVITY,
not a component skill or
some knowledge that is part of the activity.

Three levels of the concept of activity (from the general to the specific):

- THE ACTIVITY ITSELF
- ACTIONS--associated with a particular goal or subcomponent of the activity
- OPERATIONS--associated with the conditions necessary to carry out an action

Adapted from Leont'ev, 1981.

An example of how activity theory might apply to water resources can be illustrated in an activity designed to determine the quality of the water in the Grand River (the activity level). In order to determine water quality, a number of analyses need to be done e.g. turbidity, dissolved oxygen, presence of coliform bacteria, pH, temperature, etc. Each analysis constitutes one component (action level) of the entire activity of determining water quality.

In order to carry out each analysis, students must understand the meaning of the vocabulary and the directions for conducting the analysis (operations level). The operations of reading instructions and understanding the

vocabulary and diagrammatic directions are necessary conditions for carrying out the actions but are not sufficient in and of themselves. Thus, it can be said that specific operations (reading, understanding vocabulary, figuring out diagrams, etc.) are necessary components of an action that must be used appropriately for the action to be successfully carried out. Similarly, a series of actions must be appropriately carried out in order that the entire activity is complete. The complete activity is successful once the entire activity has been finished and the initial goals have been achieved. The concepts included in activity theory shed light on the levels within a science activity where a student may become confused or make a mistake in thinking and/or in carrying out a task.

Activity theory also suggests that children learn holistically rather than in discrete components. They remember the activity as a whole rather than as component parts. Once children have a number of similar, yet different whole experiences, a set of activities can serve as baseline data needed for making inferences, analyzing differences and separating the experiences into component parts. In addition to being able to analyze component parts from a series of activities, students are able to begin to make generalizations and connections between and across the activities. After children share their inferences and generalizations, they determine the relative importance of their results through social interaction. It is such social interaction, that helps a child establish the relative importance of remembering an activity and its component actions and resulting conclusions.

Understandings of activity theory may facilitate scientific literacy as students act as scientists. In Figure 14, scientific literacy is described by adapting an activity theory approach. Science concepts, processes and attitudes interact as students attempt to create meaning and gain understanding of science as a discipline.

Figure 14 **SCIENTIFIC LITERACY PROCESS**

In the process of becoming scientifically literate,

students are learning what science processes are for,
(for finding out answers to questions)

they are learning how to carry out scientific processes,
(observation, data collection, hypothesis, experimenting)

and they are learning about science.
(science content)

In other words, becoming scientifically literate is a multifaceted process involving attitudes (towards science, scientific processes, and scientists), knowledge (about science content), skill (in science processes) and self-monitoring (checking one's observations, inferences, conclusions, and thinking processes).

Adapted from Teale, 1990, p. 48

The **fourth characteristic** of Great Lakes and Other Water Resources includes the **discussion of data, observations, interpretations and results to formulate an understanding of the implications of findings** (Figure 10, item 3). When the PRISE proposal was written, the relationship of this fourth aspect of PRISE to theories of Vygotsky (1978) and cognitive psychologists studying metacognition (Whimbey and Lockhead, 1982) had not been linked. Both require learners to share observations and thinking processes in order to make better generalizations and clarify thinking. Sharing also is included in the third phase of active learning, in making generalizations about an activity, and in the self-monitoring phase of becoming scientifically literate. It is through sharing that there is an opportunity to test analyses, syntheses, generalizations and the relative importance of information. As Wertsch points out, verbalization is an important aspect of internalization (1981, p.32). Internalization is crucial to memory and retention.

The **fifth aspect** of Great Lakes and Other Water Resources is the **integration of ideas from differing subject areas within and outside science disciplines** (Figure 10, p. 9). How areas may be integrated within the course is evident in a field trip activity on the D. J. Angus research vessel. In this activity, students act as "novice scientists," make observations, do measurements, do experiments, and record data regarding water conditions. From these, they make inferences, share their ideas and challenge each other. Students do not differentiate science content by subject discipline, instead they integrate any relevant information and apply it to the situation at hand. Figure 15 outlines how science content may be integrated in this experience. Students learn information from biology, chemistry, earth science, and physics while studying on the research vessel.

Figure 15 INTEGRATING SCIENCE DISCIPLINES IN OUR WATER RESOURCES

BIOLOGY, CHEMISTRY, EARTH SCIENCE, PHYSICS

* Biology - microbial life, algae, fish, crustaceans, ecology eco-system
* Chemistry - pH, solubility, density
* Earth Science - river plume, bottom composition, wave action, water temperature at various depths
* Physics - water density, conductivity

Observations from a D. J. Angus Field Trip

It is also possible to integrate information from science disciplines with other disciplines in this activity. As students carry out investigations, they use language arts and mathematics skills. As they suggest consequences of the data, they may draw upon social science and health constructs (Figure 16).

Figure 16 INTEGRATING NON-SCIENCE DISCIPLINES IN OUR WATER RESOURCES

MATHEMATICS, LANGUAGE ARTS, SOCIAL SCIENCES, HEALTH

* Mathematics - making measurements, doing statistical calculations, comparing numbers, doing operations, graphing

* Language Arts - recording data, stating conclusions, reading directions, listening to others' observations, sharing one's observations and predictions, keeping a journal

* Social Sciences - identifying the significance of water transportation, discussing the economics of fishing, discussing water pollution and environmental decision-making including the social, legal, political, environmental, and economic implications of observations and conclusions e.g. Zebra mussels

* Health - discussing water purity, pollutants, concentrations of pollutants in fish, and the health implications of drinking the water and eating the fish

Observations from a D. J. Angus Field Trip

Such integration is consistent with directions taken by Project 2061.

> "A fundamental premise of Project 2061 is that the schools do not need to be asked to teach more and more content, but rather to focus on what is essential to scientific literacy and to teach it more effectively"
> (American Association for the Advancement of Science, 1989, p. 4).

It also promotes the "less is more" perspective. For example, if one understands the various biological, chemical, geological, meteorological, physical and technical aspects of investigating and determining water quality, it may be possible to extend one's understanding to air quality, ground water quality or even quality control. Thus, "less is more" suggests that an in-depth understanding of one complex activity may yield a level of understanding that can be more readily transferred to new situations, than can superficial coverage of a variety of topics without any in-depth understanding of any of them. It is consistent with brain research as noted by Caine and Caine (1991), "brain research establishes and confirms that multiple complex and concrete experiences are essential for meaningful learning and teaching." (p.5) To make generalizations across activities requires sharing, to determine the extent and limits of similarities and differences between activities. This is necessary "because the learner is constantly searching for connections on many levels, educators need to orchestrate the experiences from which learners extract understanding. They must do more than simply provide information or force the memorization of isolated facts and skills." (Caine and Caine, 1991, p. 5.). PRISE attempts to do just this.

Phase Three: **Step 3. Provide opportunities for faculty members to become familiar with developments in science education through attendance at conferences, bringing experts in to share their perspectives, through faculty interactions and participation in the theme course's content and processes with PRISE students and other faculty members, sharing of articles and books on science education, and visits to elementary science and regular classrooms.**

Just as students are asked to investigate and integrate information across disciplines, PRISE faculty members are asked to do the same by extending their knowledge bases in science education and elementary education. To facilitate information gathering and sharing, PRISE used a variety of mechanisms, such as circulating readings (see attached reading list), attendance at meetings, participation in workshops, visiting schools, and talking with others about the project. Some of the means PRISE used for sharing information are listed in Figure 17.

The presentations and informal discussions by science educators were found to be particularly influential on the thinking of the PRISE faculty. The Katz workshop entitled, "Chemistry in a Toy Store," got the faculty members involved in doing science activities that could be used by elementary school teachers.

Figure 17 OPPORTUNITIES FOR GAINING INFORMATION ON SCIENCE EDUCATION

- Participate with the PRISE Advisory Committee in identifying important content and processes needed in the elementary school

- Attend the annual meeting of the National Science Teachers Association

- Attend workshop by David Katz on "Chemistry in a Toy Store"

- Participate with students in the theme course, "Our Water Resources," as the students conduct their investigations

- Have presentations by and hold conversations with noted science educators concerning their perspectives on science education (McDermott, Poole, Berkheimer, Freidl, Kuerbis)

- Visit elementary classrooms and observe elementary classroom and science teachers working with pupils

- Read and share articles, textbooks, state objectives, and other science resources

- Interact with other science and education faculty members to discuss how to achieve the desired goals and objectives

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Poole pointed out most teachers are consumers (Figure 18) of curriculum materials rather than developers of curriculum ideas. Poole, Freidl and Kuerbis indicated that it is very important that the models of teaching and learning science content and processes used in PRISE courses be ones that would be appropriate for prospective teachers to use in elementary school classrooms.

Figure 18 TEACHERS AS CONSUMERS OF CURRICULUM

* Most beginning teachers are not creative with the curriculum
* Most beginning teachers rely heavily on what is in the textbook
* If teachers vary from the textbook, it is likely to occur in areas in which they feel comfortable with the content and processes
* Most beginning teachers model science as it was taught to them by their college, high school, and elementary school instructors
* Science is not a high priority subject in elementary classrooms thus, less time is likely to be put into preparing for science instruction given that numerous subjects must be taught daily

Notes from R. Poole Presentation at GVSU, 1990

Kuerbis also suggested that the learning process is similar for prospective teachers and their pupils and that the "constructivist model of how students learn science provides a model of how teachers learn as well.

> "Constructivism asserts that learners construct unique organizations of their emerging knowledge of the world by integrating new information with prior knowledge....We need to recognize the students point of view and provide activities...that guide students to reconstruct their current view into a new view....This process, while idiosyncratic to each learner, probably is achieved more effectively when the learner has opportunities to share viewpoints with his or her peers and the teacher." (Kuerbis, 1991, p. 1)

The constructivist instructional model challenged the faculty members to Invite students to Explore through hands-on experiences then propose new explorations, Explanations and Solutions. The process does not stop with the explanation or solution but is applied by Taking Action. By taking action, students act on their new knowledge and skills in a meaningful manner which helps to fix their new understandings in their minds.

Just as Kuerbis' recommendation of using a constructivist instructional model to help students reconstruct their knowledge, Lillian McDermott (1983) introduced the faculty to some ways of addressing students' misconceptions about physical phenomena. The use of activities, questioning, and sharing was found to be particularly relevant to PRISE. It is through reflecting and questioning processes that misconceptions are more clearly identified, self-monitored, and self-corrected. McDermott's work was considered as the basis for the development of a PRISE physics course.

A different way of sharing relationships between concepts was suggested by Berkheimer (1990) as he described a system of unit planning including concept mapping. Mapping can facilitate an understanding of relationships within and between concepts and disciplines. It was found to be particularly helpful in the PRISE course: Earth Science in Elementary Education.

During the sharing phase, faculty members became involved in the project, shared observations with each other, and tested out ideas against each other. As they did this, they begin to apply the ideas to the proposed PRISE sequence (Figure 19) and the development of their courses.

Figure 19 **PROPOSED PRISE COURSES**

All Preservice Elementary Teachers Will

- Complete the OUR WATER RESOURCES course
- Complete a minimum or two courses selected from
  Biology 111
  Chemistry 111
  Geology 111 OR
  Other courses the Committee might deem more appropriate
- Participate in the one-credit discussions offered as supplements to
  Biology 111, Chemistry 111 and Geology 111

PRISE Proposal to NSF, 1988, p. 6

PHASE FOUR: The linkages between component parts of the project indicated in Figure 19 began to be challenged as faculty members questioned whether an add-on one-credit discussion section was the most appropriate way to prepare elementary teachers. As they identified course limitations, the faculty began the creative phase of curriculum development. In the **creative phase** faculty members begin **developing and piloting** of courses. The components of this phase are outlined in Figure 20.

Figure 20 **MODEL FOR REPLICATING PRISE**

Phase Four: CREATING, DEVELOPING AND PILOTING PRISE COURSES

Step 1. Develop the theme course, identifying the integrated science content, process skills, investigative experiences, and model instructional strategies designed to achieve the identified goals and objectives

Step 2. Develop the courses or course components in the specified science disciplines that build on the theme course

Step 3. Gain approval for offering the course through the university curricular process

Step 4. Teach, evaluate and revise he theme course based on data from students, faculty and evaluator, who assess achievement of stated goals and objectives

Step 5. Teach, evaluate and revise the specified science disciplinary courses that build on the theme course based on data from students and faculty member, who assess achievement of stated goals and objectives

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Phase Four, Step 1. Develop the theme course, identifying the integrated science content, process skills, investigative experiences, and model instructional strategies designed to achieve the identified goals and objectives

Since Our Water Resources was developed and taught prior to and concurrent with the PRISE workshop, faculty members had the opportunity to participate with students in course activities and review course content. They also could see how the objectives were translated into class activities. It was helpful to have the theme course developed enough to provide a basis for discussion concerning how the other courses might build on this course. The revised objectives are listed in Figure 21 for Great Lakes and Other Water Resources, the revised title.

The theme course is intended to be the entry course into the PRISE sequence of science courses. It is followed by a series of discipline-based courses in geology, physics and chemistry. The extent of articulation and sequencing among the courses continues to be under discussion.

Figure 21 OBJECTIVES OF BIOLOGY 107: GREAT LAKES AND OTHER WATER RESOURCES

Through this course students will

* gain direct experiences in gathering and analyzing data about water resources throughout west Michigan

* learn concepts of biology, chemistry, geology and physics by participating in a hands-on, investigative study of the area's water resources

* understand the experimental processes of science by engaging in problem solving activities related to current water resources issues

* develop an interest in and a confidence with science which will lead to a clearer appreciation for the role of scientists in today's society

* increase their knowledge of the use of scientific instrumentation and analytical procedures as applied to solving environmental problems

Biology 107 Syllabus, Lubbers, 1990

Phase Four, Step 2. Develop the courses or course components in the specified science disciplines that build on the theme course

The supporting courses are revised and/or developed to build on the content, processes, and conceptual development promoted through the project. At Grand Valley, science faculty members, who participated in the PRISE workshop, felt that having preservice teachers take general education science courses did not serve the purpose of PRISE. Thus, instead of developing just a

one-credit discussion session to be associated with the designated science survey courses, the faculty developed plans for new courses.

Deciding on course content became the first task of the faculty. Content for inclusion was judged by criteria such as its relevance for prospective elementary teachers, how it relates to the objectives of PRISE and science education, and how it represents an understanding of the discipline. Choices of instructional resources and teaching strategies followed.

Once the courses were developed, it became possible to see the continuity in the instructional models, scientific content and scientific processes throughout the sequence. Similarities and differences between the project's courses became apparent. All courses are activity based. The linkage to the water theme varies: an extensive unit on the hydrosphere and water cycle is found in earth sciences; water density is investigated in the physics course; solubility is covered in the chemistry course. All courses relate to the elementary classroom. For example, the earth science course objectives (Figure 22) focus on the background of concepts taught in the elementary school.

Figure 22 GEOLOGY 201: EARTH SCIENCE IN ELEMENTARY EDUCATION

COURSE OBJECTIVES

The overall objectives of this course are to integrate factual knowledge of the Earth's lithosphere, hydrosphere, atmosphere and its place in space and time with a conceptual understanding of the dynamic processes which have formed and are constantly changing these "spheres". Specifically, this course is intended to demonstrate to the pre-service elementary teacher how to give elementary students a better conceptual grasp of the natural world around them.

The aim of Geology 201 is to teach future teachers in a manner they will be able to emulate in their future classrooms. In concert with the recent "less is more" battle cry in science education, GEO 201 will attempt to cover specific classroom and field trip activities in each of its topic areas. We hope to minimize the memorization of terms and stress the understanding of basic concepts. It is the goal of this course to make the students feel comfortable with those aspects of earth science that are covered in the activities so that they will be able to use them in their own classrooms after they graduate.

Geology 201 Syllabus and Proposal, Lefebvre, 1990

Lefebvre demonstrates concept mapping within Geology 201 (See attachment). Concept maps can be used by these prospective teachers in their future classrooms. The course demonstrates how information from the theme course can be articulated into another as it reviews the steps in the water cycle, states of matter, erosion, sedimentary rocks, etc. It also models activities that can be used with elementary students such as peanut butter and jelly geology and active learning with field trips, visits to elementary classrooms, etc.

Physics 201 continues the emphasis on using activities that are appropriate for youngsters, as well as emphasizing concepts in physical science (Figure 23). This course builds on the theme course philosophy. An additional

physics course that emphasizes critical thinking and concept development on the McDermott model continues in its development.

Figure 23 **PHYSICS 201: PHYSICAL SCIENCE FOR ELEMENTARY TEACHERS**

Course Objectives and Philosophy:

The primary objective of this course is to provide the prospective elementary classroom teacher with the background necessary to teach the physical science found in the typical elementary curriculum.

An objective is to provide the prospective elementary teacher with some hands-on activities they will be able to take with them and adapt to their classroom situ tion. It is hoped that the student will leave with the confidence to be able to present these activities in their classroom on their own.

Because the best way to learn physics is by active involvement, the lectures, demonstrations, and the laboratory activities will be blended together.

It will be taught in a manner that models teaching methods effective for educating elementary school students.

PHY 201 will be a laboratory-based course which will explore a wide variety of directly observable physical phenomena (Motion, sound, heat, temperature, electricity, magnetism, light, etc.) in a way which will provide the student with experiences transferable to the elementary classroom. Only common materials, readily available in supermarkets and hardware stores, will be used. National data indicate that o er 90% of elementary teacher supplement their school budget out of their own pocket for teaching supplies....Emphasis will be placed on understanding the observed phenomena, verbal description and explanation, and the formation of science concepts underlying the phenomena.

Physics 201 Syllabus and Proposal, Luttikhuizen, 1990

The chemistry course includes objectives similar to those of the other PRISE courses (Figure 24). In addition, it develops technological capability in prospective teachers by having each student make simple testing equipment that they can take with them at the end of the course. The content of this course integrates prior knowledge of density, matter, and pH attained in the theme course. It also relates chemical concepts to real problems such as waste water and water purification. Each course helps develop thinking skills by asking students, "How do you know what you know?"

Phase Four, Step 3. Gain approval for offering the course through the university curricular process

The approval process follows a unique procedure at each institution. At Grand Valley it follows a path from the faculty proposer to departmental consideration and approval, divisional approval, general education approval, and university curriculum committee approval. As the courses have gone through this process, one question that has been raised is, "Why can't all non-science students have such a course?" This raises new questions for PRISE to consider.

Figure .' CHEMISTRY 201 CHEMICAL SCIENCE IN ELEMENTARY EDUCATION

Course Objectives:

1 To develop an understanding of some of the concepts of chemistry.

2 To help students realize that an understanding of some of the principles of chemistry will help in the understanding of the behavior of the physical world

3 To have students experience on a first hand basis physical and chemical changes on some simple systems.

4 To provide students with a hands-on, investigative experience in science.

5 To provide science process experience for students.

6 To encourage effective teaching through modeling desirable methodology.

7 To encourage students to elect more science courses, possibly even choosing to minor in science.

8 To help students develop an interest and understanding of science in general, and chemistry in particular, so that as elementary teachers, they will have confidence in their ability to teach science with a reasonable degree of competency.

Chemistry 201 Syllabus and Proposal, Knop, 1990

Phase Four, Step 4. Teach, evaluate and revise the theme course based on data from students, faculty and evaluator, who assess achievement of stated goals and objectives

The need to pilot the theme course is important because it lays the foundation for the other courses. That foundation must be sound both from the point of view of the faculty and those of the students. In addition, the project's goals need to be achieved. For this reason, this process is of utmost importance.

Phase Four, Step 5. Teach, evaluate and revise the specified science disciplinary courses that build on the theme course based on data from students and faculty member, who assess achievement of stated goals and objectives

Piloting of the disciplinary courses is particularly important when new courses are developed rather than just revising or adding on to existing courses. This process also is important as a new minor in science is being considered for prospective elementary teachers.

PRISE courses are evaluated for how they contribute to the achievement of the PRISE objectives, how students attitudes toward science change, and the extent to which the courses contributed to greater scientific literacy. This is facilitated by an external evaluator (Burton Voss). Results of pre- and

post-tests taken by students in the classes, Our Water Resources in 1989 and Great Lakes and Other Water Resources in 1990 on the Motz Science and Scientists Attitude Inventory indicate that their attitudes toward science increased. When prospective teachers were compared to their general education classmates, the prospective teachers attitudes toward science and scientists were significantly higher. In addition, the prospective teachers' scores on the Horsely Attitude on Issues of the Environment were found to increase significantly. There was no significant change in the students process skills as measured by the Test of Integrated Process Skills (Voss and Antony, 1991). The positive change in attitudes toward science were evident not only through the tests. Students also indicated their attitudes about PRISE courses on the course evaluation in comments such as "Truly a wonderful course. I'd take it again." or I really enjoyed the course and field trips. It opened an awareness to science education for me." The desire to expand PRISE was noted in the comment (I) "would like to see PRISE courses in other departments other than science." Numerous students taking PRISE courses were interested in taking more science courses than the university required. This was a change in behavior from prior elementary education students who had taken general education science courses in the past.

PHASE FIVE: In Phase Five (Figure 25) of the curriculum development process, PRISE attempts to share appropriate content, processes and models with others.

Figure 25 MODEL FOR REPLICATING PRISE

Phase Five - SHARING THE PRISE MODEL

Step 1. Share the components of PRISE with the PRISE Advisory Committee, PRISE faculty members, and faculty members in education and science units. This will include:

A. Theme course instruction models:
- use of prior knowledge to facilitate new knowledge
- integrated science content
- process skills
- appropriate learning theories
- development of thinking and problem solving skills
- instructional strategies usable by elementary teachers
- integration of science with other disciplines

B. Additional science course features:
- build on base (prior knowledge) developed in the theme course
- expand students' science information and process skills
- address new areas important to elementary teachers e.g.
  - misconceptions of science concepts
  - concept mapping as a way of drawing relationships
  - building and using self-made science equipment

C. Curriculum development in science education for preservice teachers having five phases

Step 2. Sharing of PRISE features with other scientists and educators through a dissemination video, report and presentations

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Phase Five, Step 1. Share the components of PRISE with the PRISE Advisory Committee, PRISE faculty members, and faculty members in education and science units.

The first step in phase five begins with internal sharing with the PRISE project members and the advisory committee. Additional internal sharing is being done with other science and education faculty members in order to integrate the PRISE ideas across the curriculum for prospective teachers and in order to test the validity of this approach for other students. This sharing will begin prior to completion of the piloting of project courses as students and faculty share in their excitement regarding the courses. Formal sharing of results will occur only after piloting is complete.

Phase Five, Step 2. Sharing of PRISE features with other scientists and educators through a dissemination video, report and presentations

By disseminating PRISE, including the five phases in the PRISE curriculum development process, other institutions should be able to replicate the PRISE project and have it uniquely tailored to use the resources of their area and the goals they wish to achieve. The unique tailoring can be inserted as the idea becomes formulated, as the project components are identified, as information is shared or as the development and piloting of the courses occurs. Each institution will need to consider its own strengths in making these adjustments in the model.

SUMMARY: PRISE is a project to improve science education by altering the type of science courses prospective teachers take. PRISE courses begin with a theme course, Great Lakes and Other Water Resources, and is expanded upon by disciplinary courses in earth science, physical science and chemistry.

The PRISE process of curriculum development began with the idea and the identification of the theme: water. The idea then was developed with its component features: audience, objectives, courses, evaluation. Sharing of the idea, information about the project, and science education requires extensive discussion, interaction, and research. This phase is particularly important in expanding faculty understanding of elementary science education, how science is learned, and how science can be taught to foster greater understanding. The learning and sharing phase is intertwined and followed by the creative course development phase. Once the courses are developed and approved, they are piloted, evaluated and revised. The project is disseminated after it is found to meet the desired goals for improvement in science education.

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APPENCICES

I. Partial PRISE Reading List

II. Concept maps for GEO 201 and 1991 PRISE spring workshops.

III. WATER, WATER EVERYWHERE booklet for children, which uses the first two stages of KWL.

PARTIAL PRISE READING LIST

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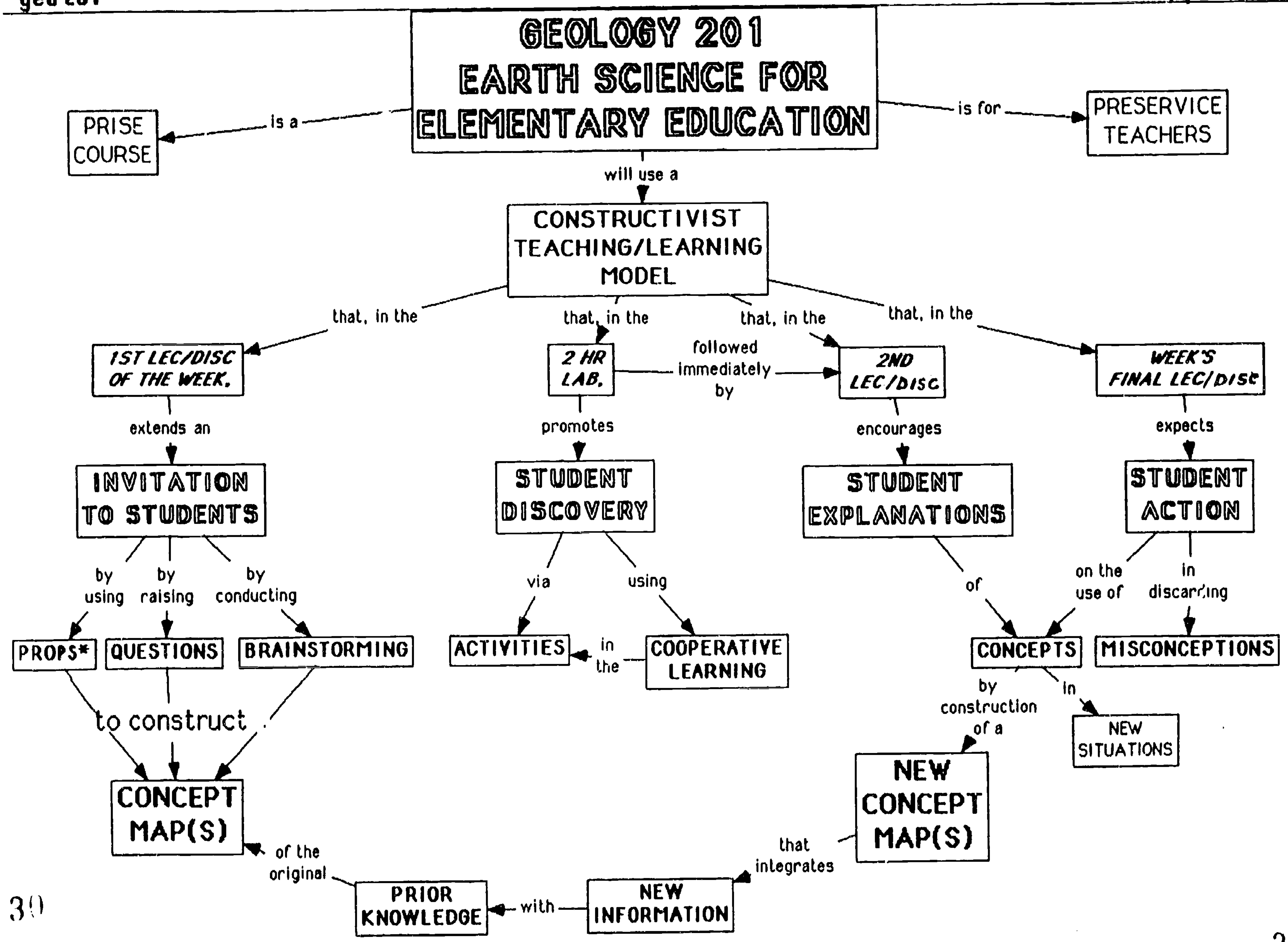
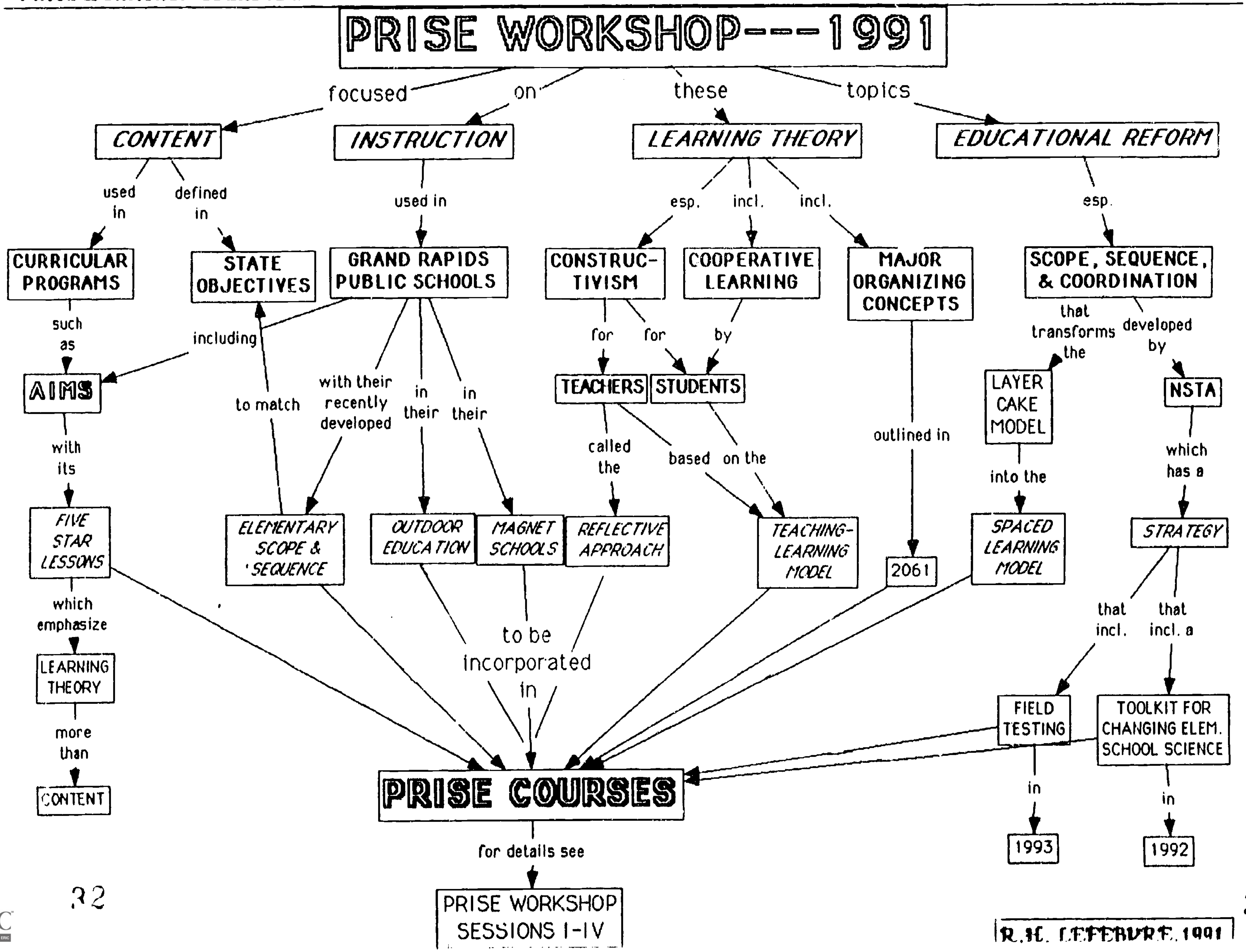


*PROPS INCL: VISUAL AIDS, SPECIMENS, MODELS, DEMOS, ETC.

R.H. LEFEBVRE, 1991



R.H. LEFEBVRE 1991

WATER, WATER EVERYWHERE

Water Activities for
Children to Do
(Young Children With Adult Help)

Loretta Konecki, Ph.D.
Grand Valley State University

WHAT DO YOU KNOW ABOUT WATER?

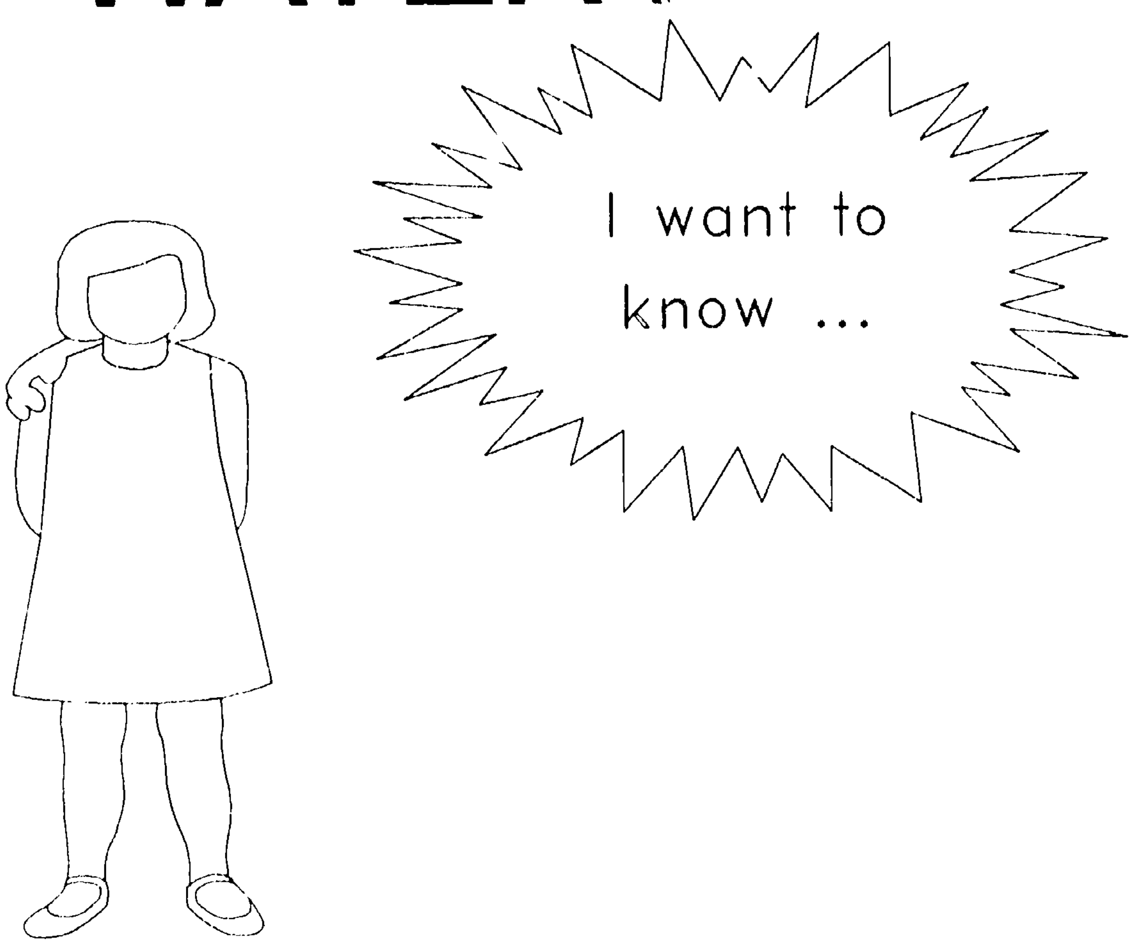
Did you think of some of the things on the back of this page?

WATER IS...

- WET (AS A LIQUID)
- A LIQUID (OR A SOLID AS ICE OR SNOW, OR A GAS AS WATER VAPOR)
- COLORLESS AND WE CAN SEE LIGHT THROUGH IT
- FLEXIBLE--IT TAKES THE SHAPE OF ITS CONTAINER WHEN IT IS LIQUID OR GAS
- NECESSARY FOR PEOPLE, ANIMALS AND PLANTS TO LIVE
- USED IN MANY WAYS
- FOUND IN LAKES, RIVERS, OCEANS AND OTHER PLACES ALL OVER THE WORLD

WHAT WOULD YOU LIKE TO KNOW ABOUT

WATER?



Did you ask some of the question on the back of this page?

Things You Might Like to Know About WATER.

What is the shape of water?

Where do we find or use water at home?

Where does water come from?

How much does it rain?

Does water come in different forms?

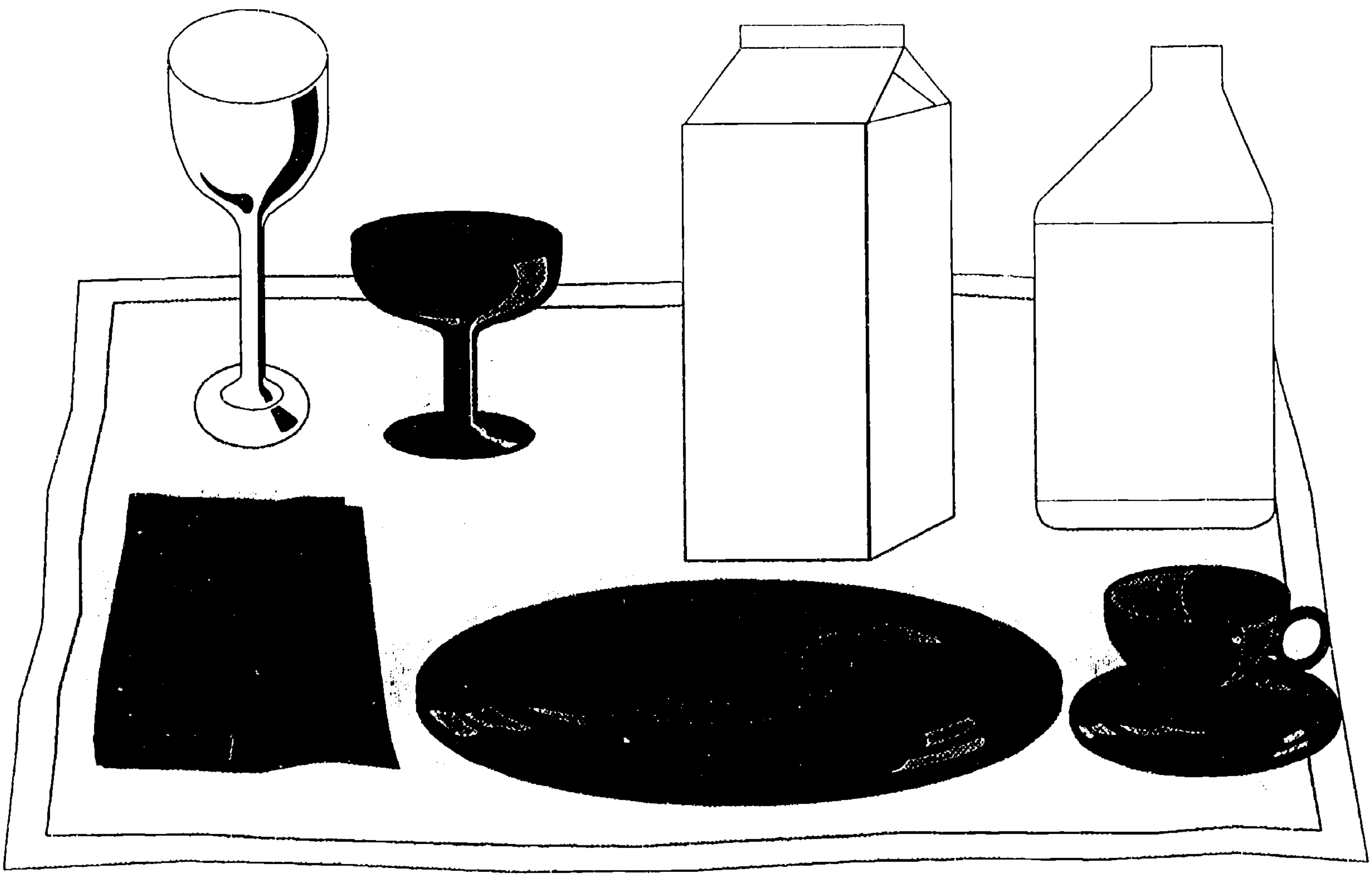
What are some things we can do with water?

What needs water?

WHAT IS THE SHAPE OF WATER?

HOW COULD YOU FIND OUT THE SHAPE OF WATER?

You may want to get some containers and some plastic or wax paper and some water.

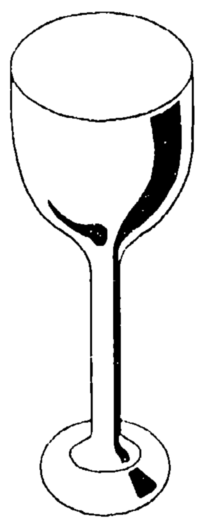


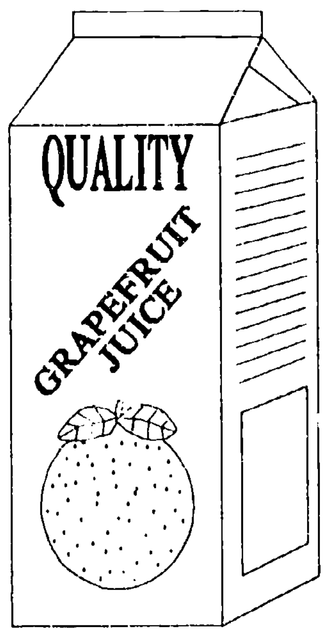
If you pour some water into the containers, what shape does it take?

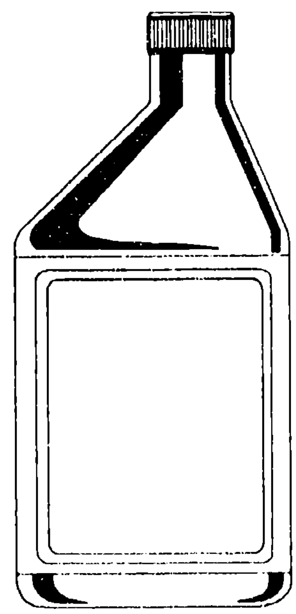
If you drop some water on plastic wrap or wax paper, what shape does it take?

Water is a Liquid and It has No Shape of Its Own

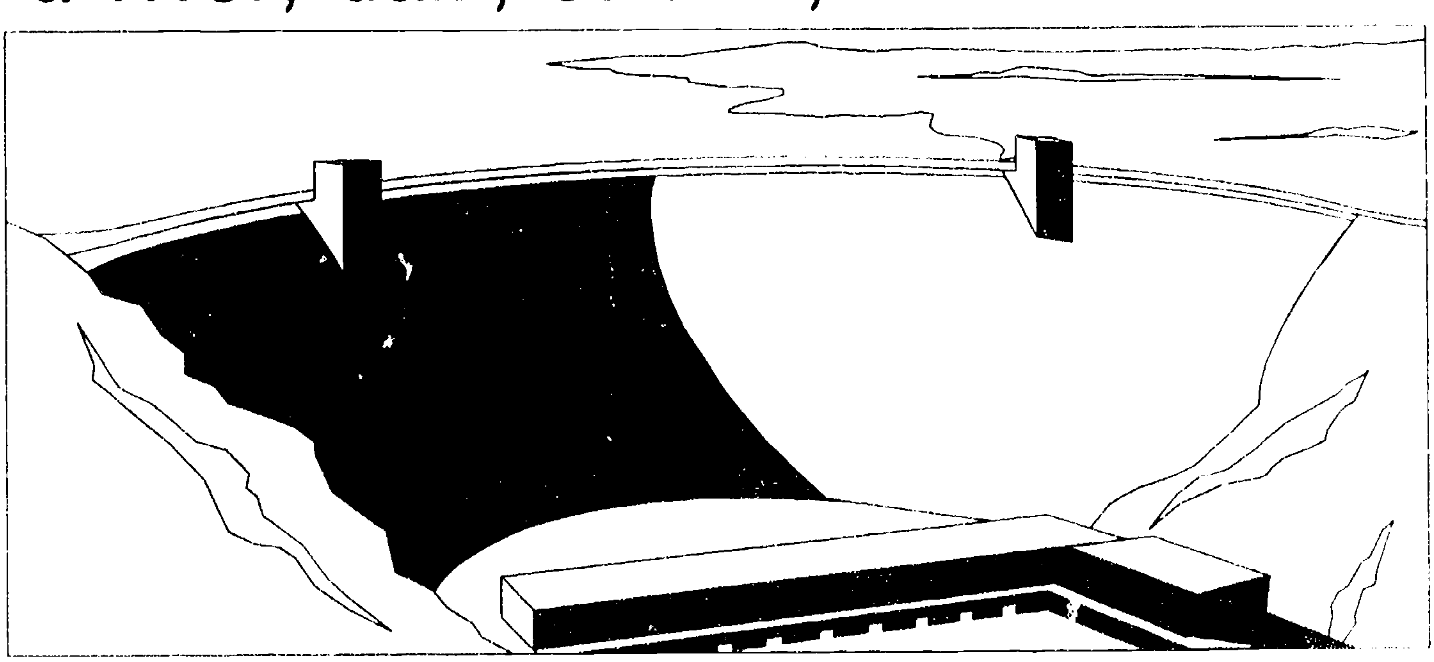
Water takes the shape of what it is in.
In a glass, it looks like the glass.
It can take the shape of a carton or jar.



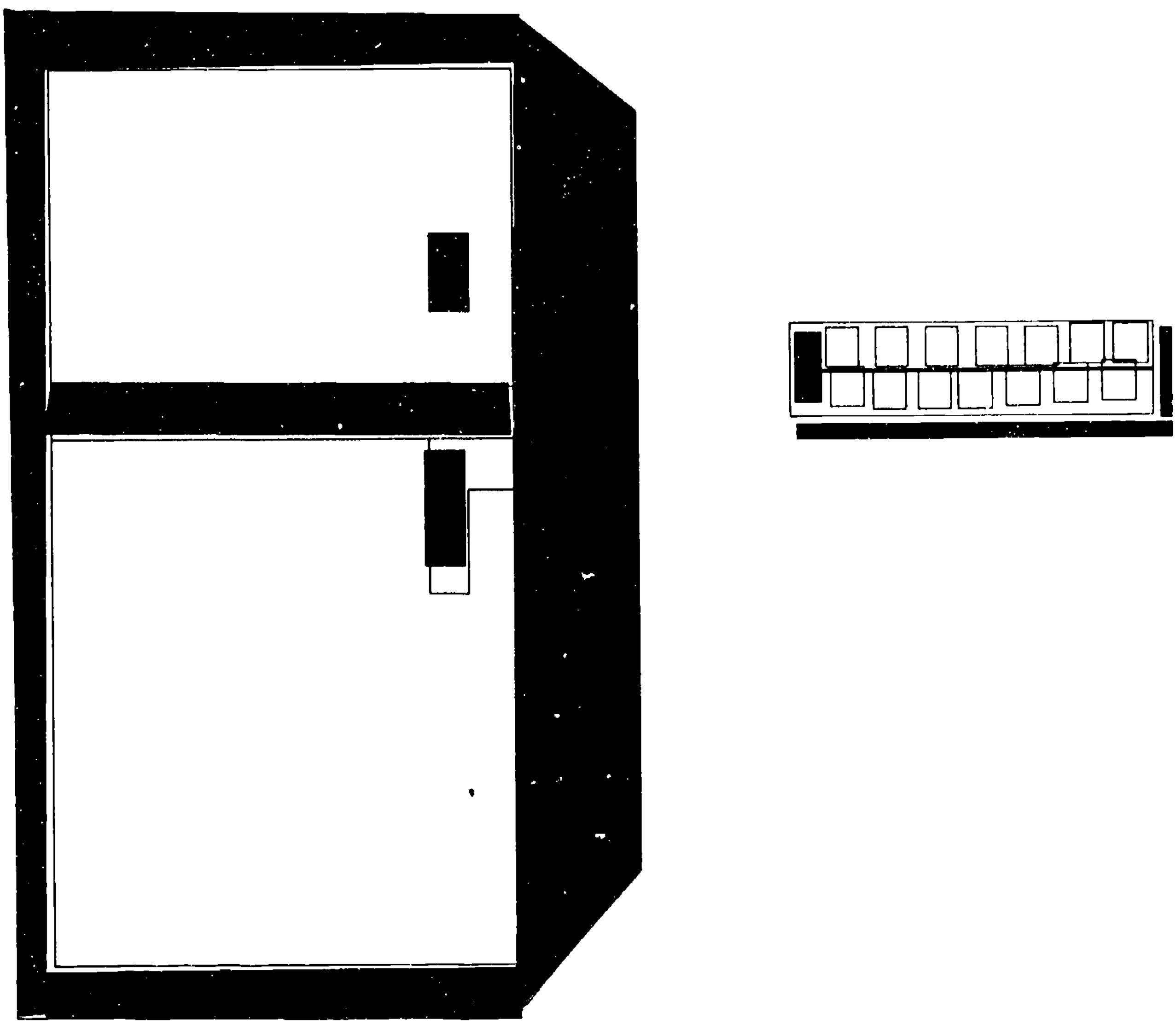




It can also take the shape of the earth in a river, dam, stream, lake or ocean.

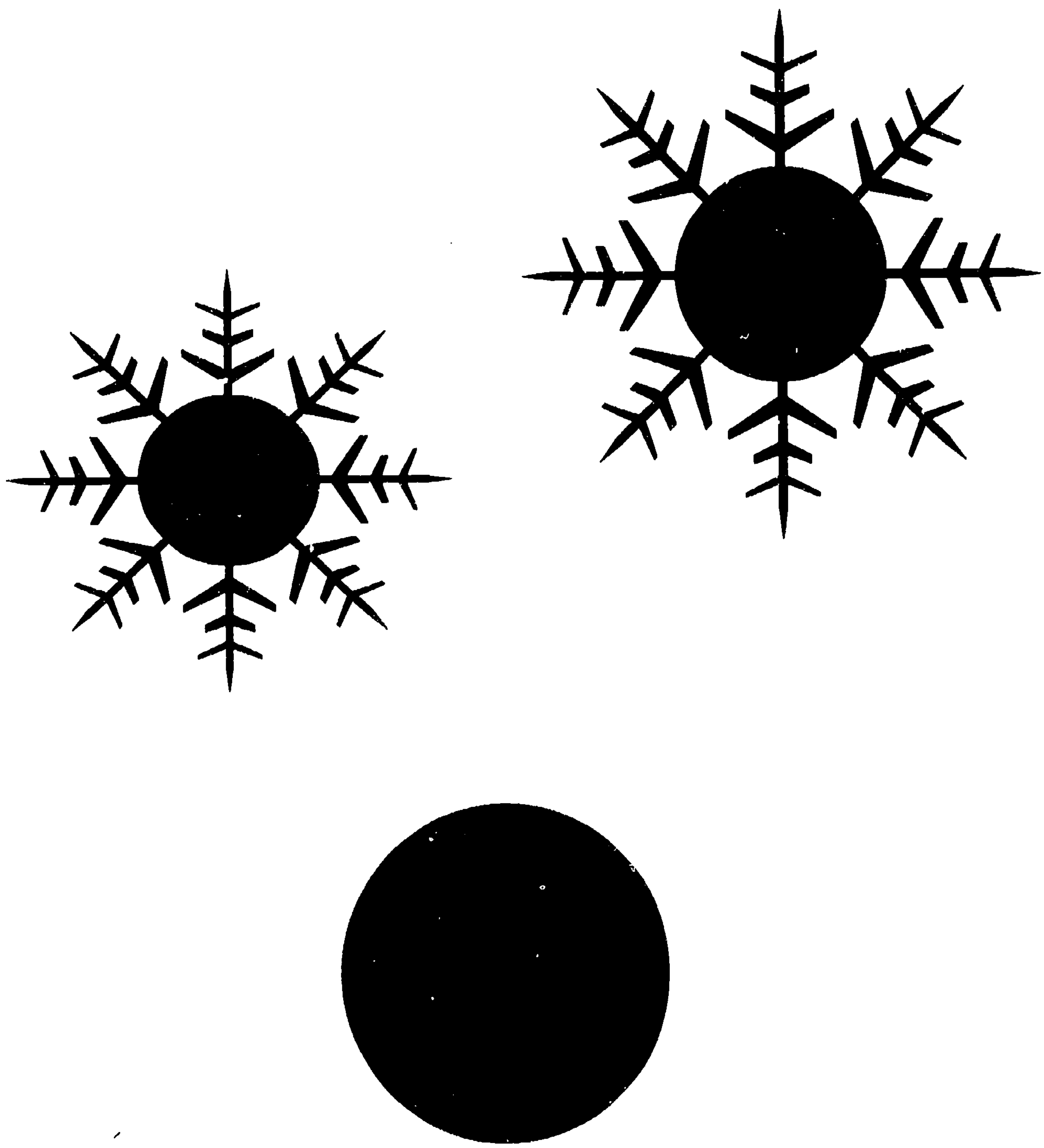


What happens to water
when you put it in the freezer?
What shape does it take?



Ice cubes are frozen water.
They are hard, cold solids.
What happens if they get warm?

SNOWFLAKES AND ICE ARE FROZEN WATER



When it snows, make a snowball.
Snowballs are make of frozen water.
They are hard and solid.

WHERE DOES WATER COME FROM?
Most WATER comes from RAIN.

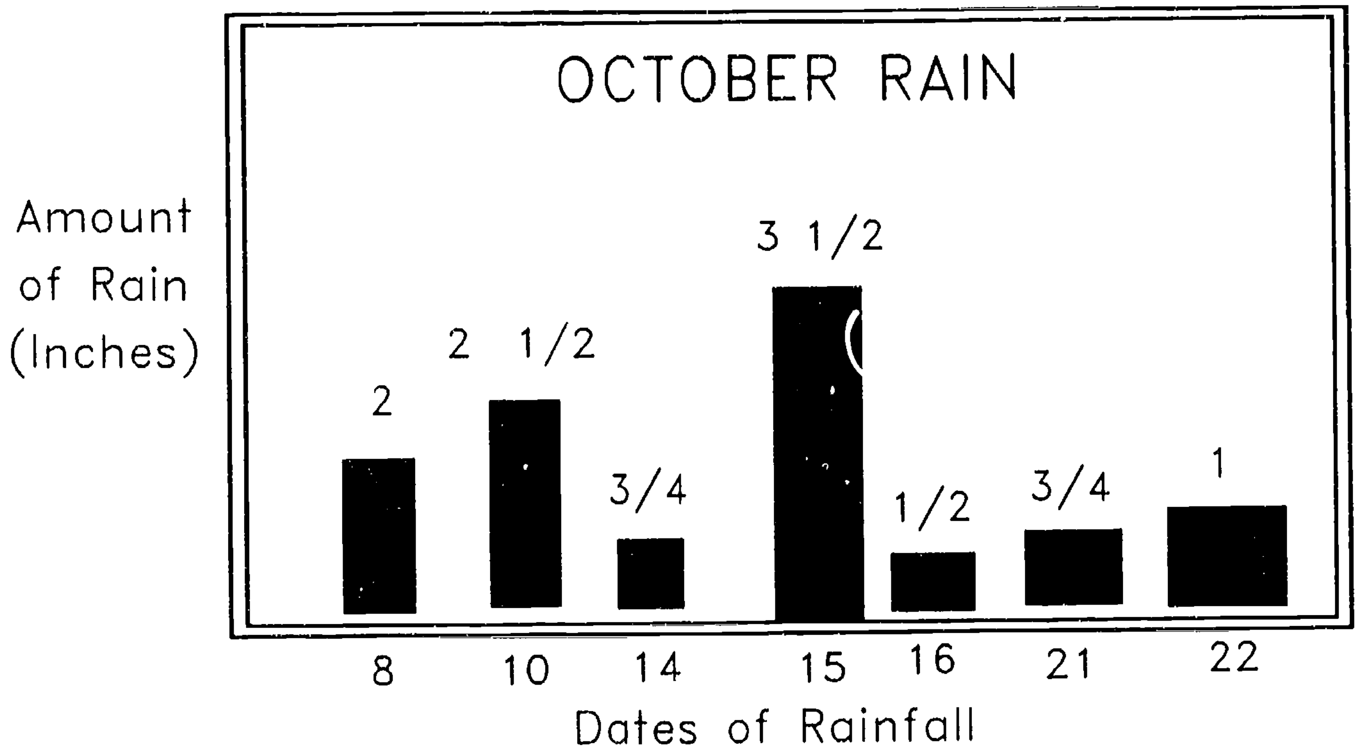
After it rains and collects in the ground, river, or lake,

how does it get to your house?

From a well? a faucet and water pipes? Ask mom or dad.

HOW MUCH DID IT RAIN?

- MAKE A RAIN GAUGE: Take plastic medicine containers that you can see through. Place them outside in open places where they will not be sheltered from the rain. For example, use a twist tie to secure a medicine container to a fence or post. Leave the containers there until it rains. After a rain, collect the medicine containers being sure not to spill any water. Measure the amount of rain collected after each rain using a ruler, piece of paper or string. You can record the amount on your calendar or make a RAINY DAY GRAPH.



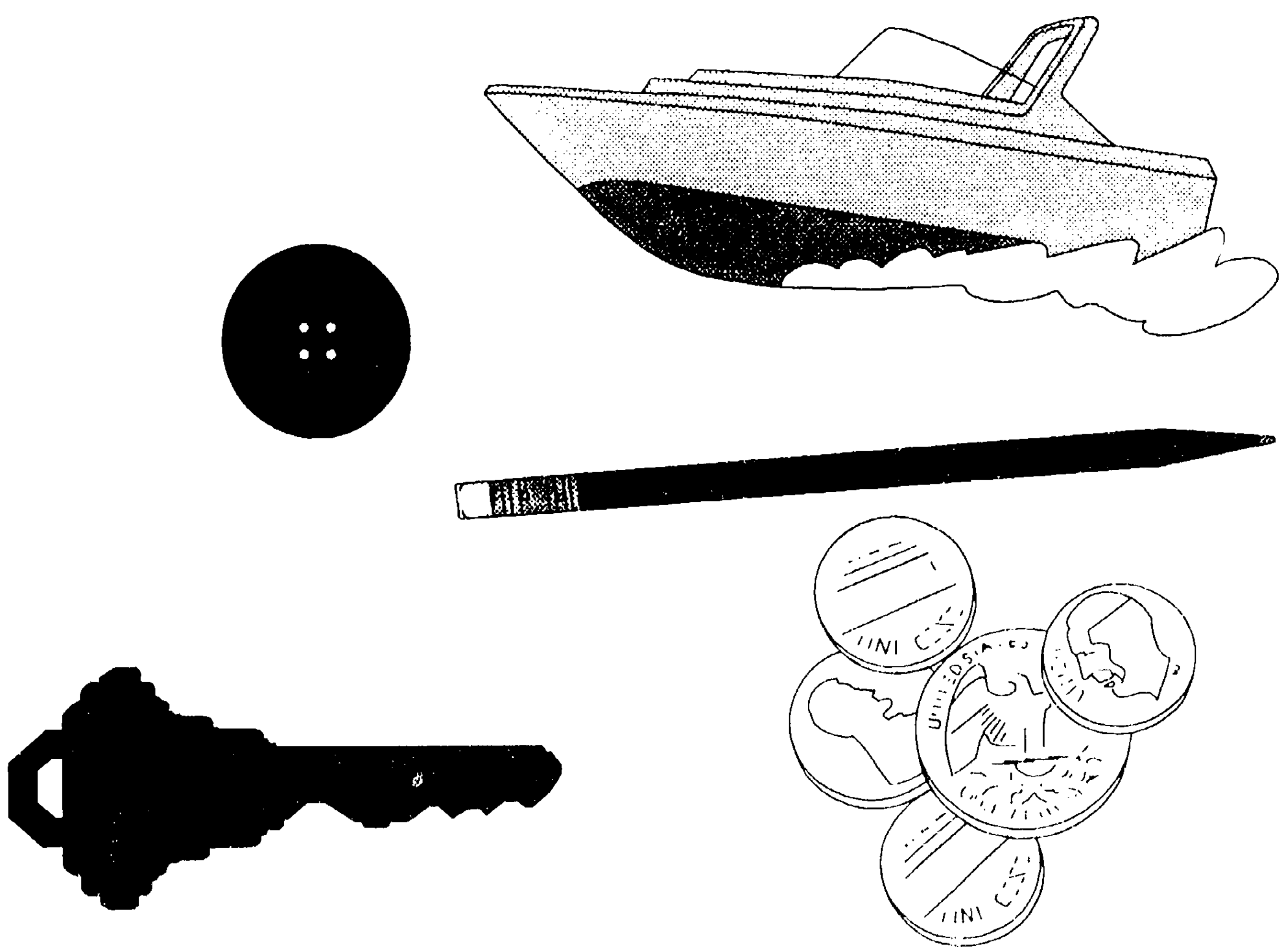
WHAT THINGS SINK IN WATER?
WHAT THINGS FLOAT IN WATER?

Gather things you can put in water.

Put them in water.

Which ones sink?

Which ones float?

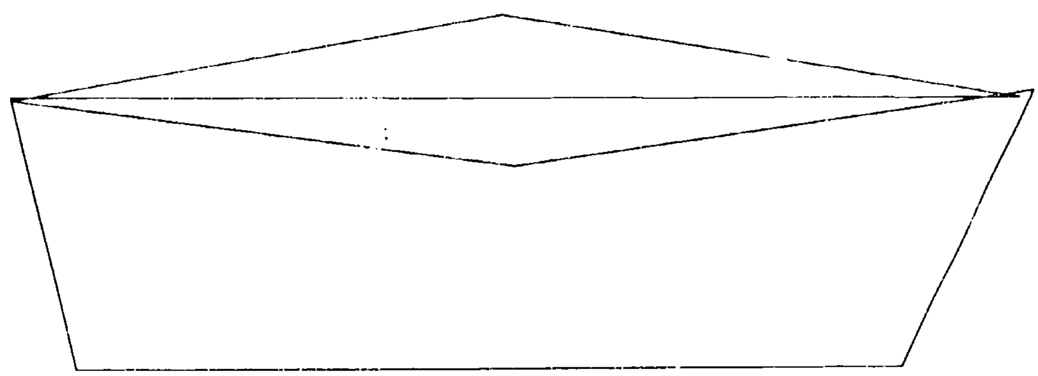


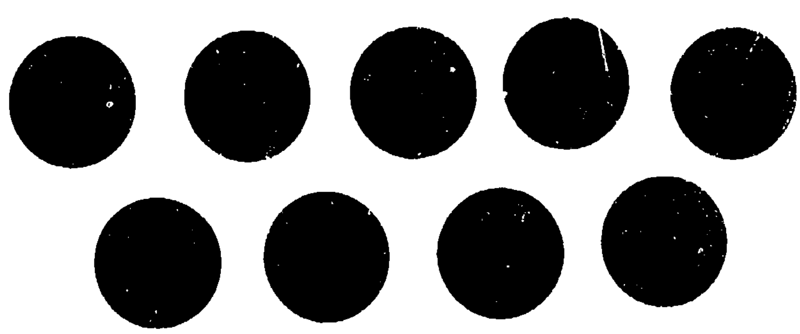
WHAT DID YOU FIND OUT?

MAKE A BOAT

Ask you Mother for a piece of aluminum foil.

Fold it to make a "boat."





How many marbles can you put in your boat before it sinks?

HOW DO YOU USE WATER?

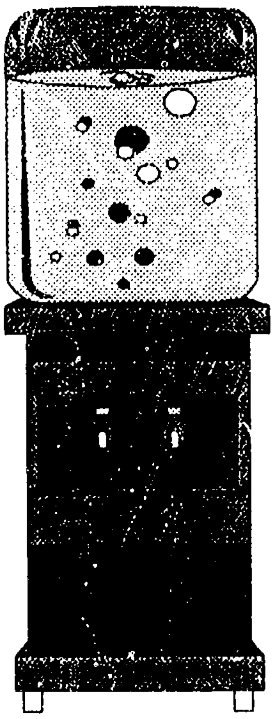
DO YOU USE WATER TO GET CLEAN?

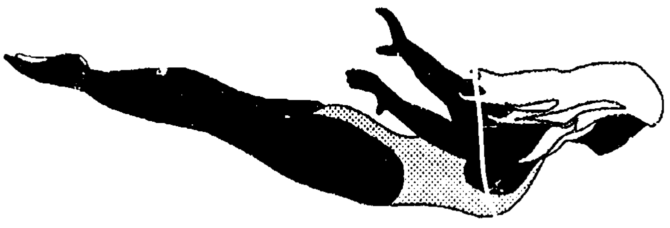
DO YOU USE WATER TO WASH CLOTHES?

DO YOU DRINK AND MAKE FOOD WITH WATER?

DO YOU USE WATER TO HELP PLANTS GROW?

DO YOU USE WATER TO HAVE FUN?



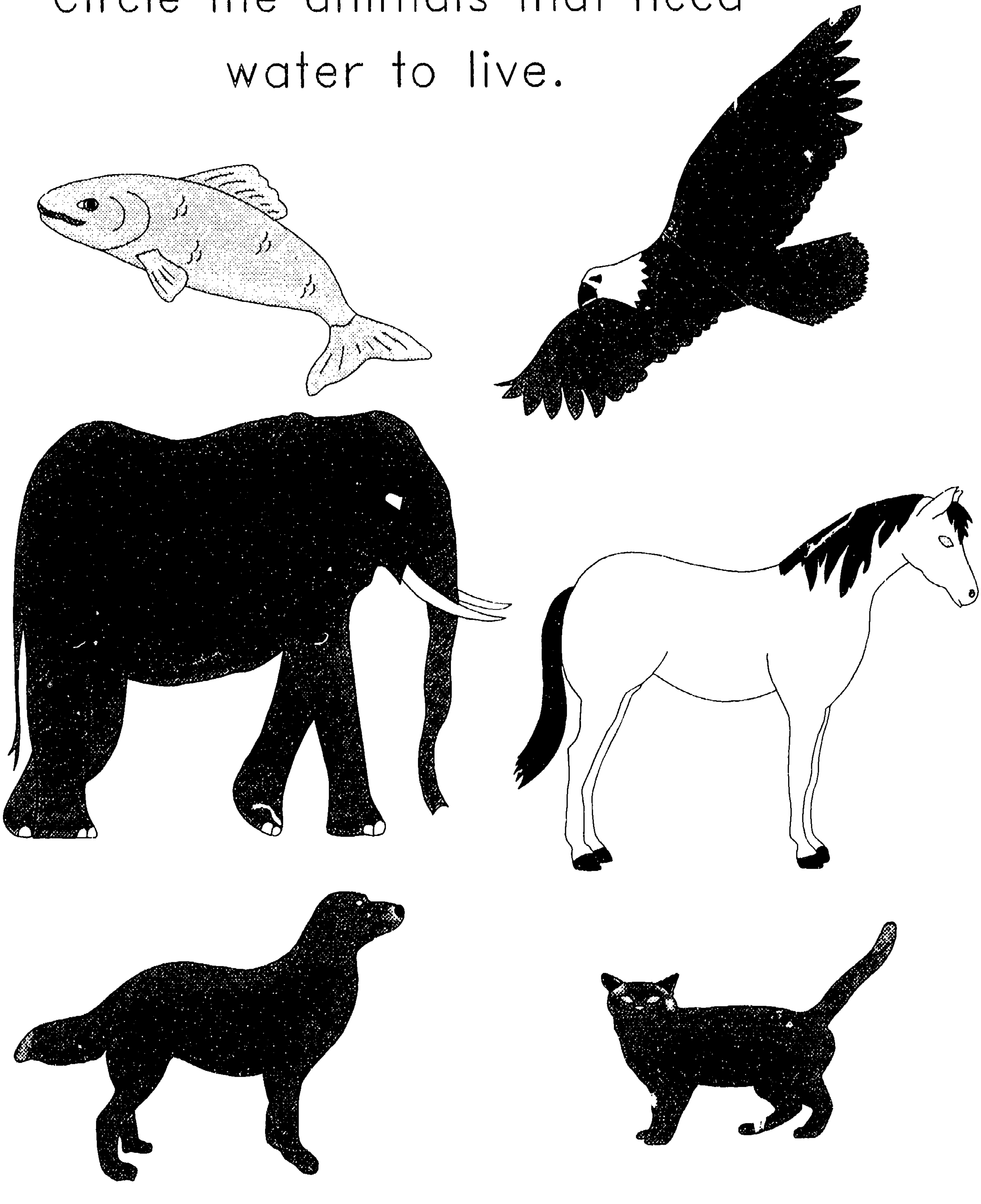


WHAT THINGS DO YOU DO WITH WATER?

WE NEED WATER TO LIVE.
IT IS IN OUR FOOD AND DRINKS.

Ask your mother if you can
help her make JUICE with WATER.

Circle the animals that need water to live.



Did you circle everything?

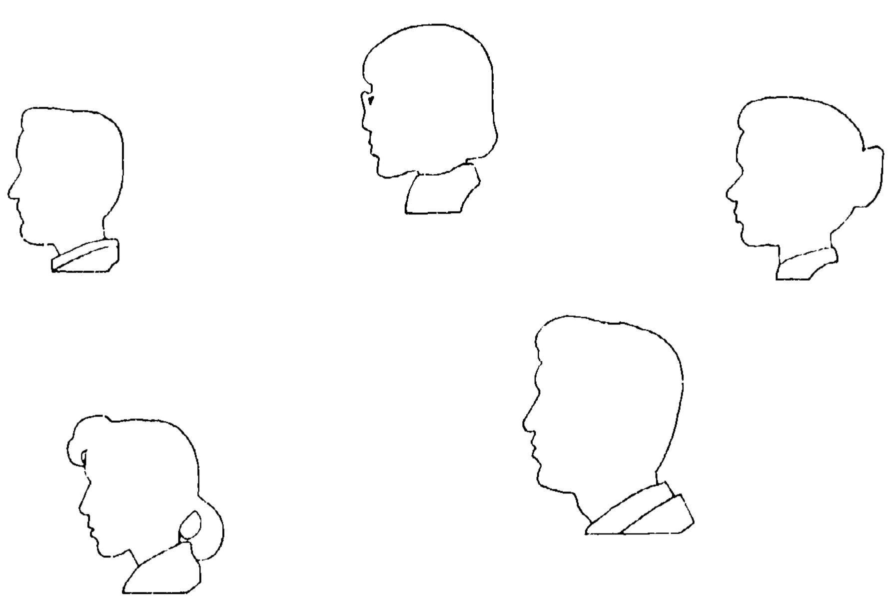
WATER IS FOUND IN RIVERS, STREAMS, LAKES, AND OCEANS ALL OVER THE WORLD

BUT, WATER IS LIMITED WE MUST HELP KEEP IT CLEAN.

HOW CAN YOU HELP KEEP WATER CLEAN?

- Could you help keep trash out of rivers and lakes?
- Could you use less water when brushing your teeth?
- Could you use less water when taking a bath?
- Could you make sure the faucet is turned off?
- Could you try not to sprinkel the street?

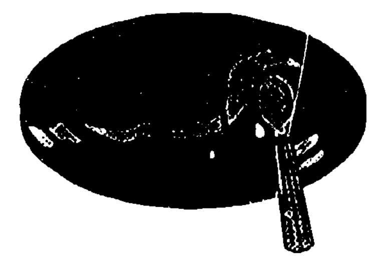
WHAT ELSE COULD YOU DO?



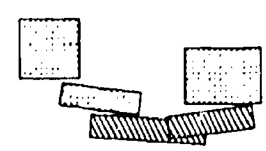
YOU CAN BE A HELPER

OTHER WATER ACTIVITIES

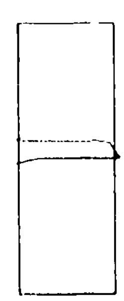
Take a cup and put it under a faucet.
Let the water drip out slowly.
How long does it take to fill the cup.
Think about how many cups of water
we waste if we let the water drip.



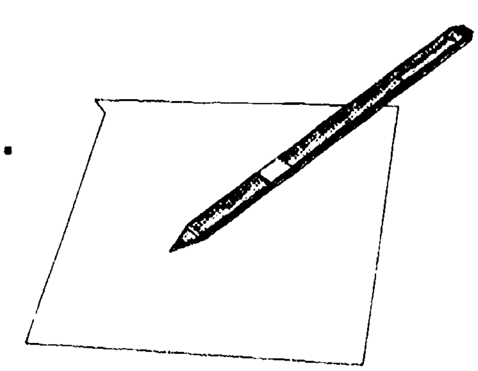
Put a spoonful of water on a dish.
Put the dish near a window.
How many days does it take for the
water to disappear?
What happens to the water?



Put red food coloring in water in
one ice cube tray and yellow in
another. Put frozen red and yellow
ice cubes in a dish or plastic bag.
What color does the melted liquid make
when they are separate or together.
Try this with other colors.



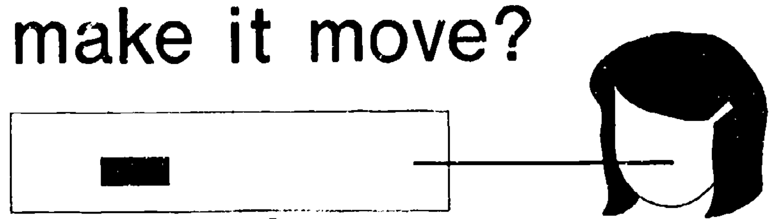
Put colored water in a tall glass.
Carefully pour some vegetable oil
into the glass. What happens?



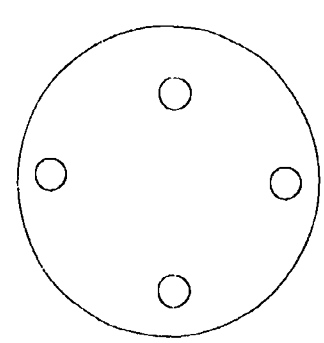
Using washable black pens, put ink
dots on a piece of white paper towel.
Wrap the towel around a glass.
Put the glass in a little water.
What happens? Look again later.

More WATER Activities

Put a small amount of water in the bottom of a cake pan.
Blow on it from one end of the pan.
Can you make waves?
If you use a straw to blow on water, are the waves the same or different?
If you put a piece of paper on top of the water, can you make it move?



Put a small amount of water in a medium-sized, flat-bottomed container. (A mayonnaise cover will do.) Drop one drop of different food colorings in the water on 4 sides. Drop one drop of liquid dish detergent in the middle.
What happens?
Try this with a little milk instead of the water. What happens?



PRISE Goals and Framework

Goals of PRISE

1. IMPROVE SCIENCE INSTRUCTION IN THE ELEMENTARY CLASSROOM

2. PROVIDE PRESERVICE ELEMENTARY TEACHERS WITH A BETTER BACKGROUND IN SCIENCE CONTENT AND SCIENCE PROCESS SKILLS

3. INCREASE PROSPECTIVE ELEMENTARY TEACHERS INTEREST AND UNDERSTANDING OF SCIENCE

PRISE Framework

The Project to Improve Science Education (PRISE) is funded by a three year grant from the National Science Foundation to develop and implement a program for the science education of preservice elementary teachers. The project involves faculty members from each of the science departments in the development of new courses that provide the content and skills most needed by elementary teachers.

The first course in the sequence establishes WATER RESOURCES as a theme that permeates the other courses and provides more of an interdisciplinary and integrated approach toward learning science. Our PRISE students will take a series of these courses, each of which includes an opportunity to teach some of the science they're learning by working with children in area schools.

All PRISE activities are monitored by an Advisory Committee made up of area science supervisors, principals, teachers and university faculty. In addition, all course development activity and student performance is being evaluated externally be Burton E. Voss, Professor of Science Education at the University of Michigan

PRISE Faculty/Departments/Involvement:

PRISE Faculty

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Water Resources Institute

Additional Principal Investigator:

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Chemistry Department

Richard H. Lefebvre, Professor
Geology Department

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Physics Department

Science Adjuncts:

Thomas Kelly, Science Supervisor
Grandville Schools

Marinus Luttikhuizen, Science Supervisor
Hudsonville Schools

The cooperation of the staffs of the Water Resources Institute and Science Departments and the support of the PRISE Advisory Committee have allowed the PRISE Faculty to maintain a clear sense of purpose and commitment toward improving science education. For more information, write to the address on this brochure or call (616) 895-37

THE PRISE CURRICULUM

The courses that comprise the PRISE curriculum represent each of the major areas of science: BIOLOGY, CHEMISTRY, GEOLOGY and PHYSICS. Each course has been designed to incorporate the science content and science process skills appropriate to the elementary science curriculum and use an integrated thematic approach based on WATER RESOURCES as a framework already familiar to the students.

The students are actively involved in a variety of activities such as data gathering and interpretation highlighted by field experiences on board the D.J. Angus, a research vessel operated through the Water Resources Institute. The instructors in these courses offer many ideas on how to teach the concepts and processes of science to children by modeling science at its best and by modeling how science should be taught in the elementary classroom

The other important component of each course is the in-school placement where PRISE students can work directly with children and with elementary teachers. They are assisted in using the course material for developing science lessons which, with supervision, they teach to children. Having such experiences early in their college years and in each of their science courses should prove to be invaluable in the development of a positive attitude toward teaching science in the elementary school

THE PRISE COURSES

BIOLOGY 107
The Great Lakes and Other Water Resources

GEOLOGY 201
Earth Science in Elementary Education

PHYSICS 201
Physical Science for Elementary Teachers

CHEMISTRY 201
Chemical Science in Elementary Education

PRISE Students

In order to improve science education in our elementary schools, the teachers must be well prepared in their own science education. This means being well versed in the nature of science, including how science works and an appreciation of the importance of science in their lives, as well as an understanding of how science is taught and learned in the elementary classroom.

To have an effective program, all players must get involved, from university faculty to elementary children. The key players, however, are the college students who are in transition between being a learner and being a teacher. Faculty must be aware of their needs and they must have opportunities with children to practice their developing skills. By the time the prospective teachers begin their student teaching, they will already have several hours of experience teaching science in the elementary classroom. Some of the reactions recently gathered...

- "...I would enjoy doing these types of things in other classes..."
- "...it gets you involved and helps you decide if this is what you really want."
- "...now I feel more confident in myself and I'm eager to be back in the classroom."

It seems to be clear that these types of experiences will lead to improvements in their confidence and "comfort level" both with science and with their new-found role as teachers.

PRISE Futures

Meeting the science needs of pre-service elementary teachers is only the beginning. Important spinoffs of PRISE already include discussions on how the philosophy of PRISE can be adapted to general education courses, and how PRISE can be implemented in the secondary science education program. In general, PRISE has significantly raised the level of awareness of the importance of teaching, the importance of science and the importance of working together.

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PRISE

PROJECT TO IMPROVE SCIENCE EDUCATION

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END

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